Bioenergy Policies and Their Implementations in Indonesia

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Abstract: Indonesia enjoys abundant supply of biomass, which is useful for energy production and several other purposes. The exploited biomass for energy production should be non-edible or industrial residues. Despite of huge bioenergy potential, most energy demand is covered by imported fossil fuels. Appropriate government policies are required to improve such an energy condition. For instance, energy demand in the future will be managed efficiently and covered mainly by renewable energy and the fewer rest by fossil fuels. Road maps for biofuel production and mandatory use until 2025 have been launched. Feed-in-Tariffs for electricity generated from biomass, biogas and MSW have been introduced and revised several times in order to attract more investors. However, many barriers for improvements must be overcome, especially the existing fuel subsidy and poor support for bioenergy investment. Most electricity generated by private companies are off-grid and used internally for production process. Blending of diesel fuel and FAME was introduced since 2006 and recently it reaches B-10. Real experiments with B-20 are conducted currently on streets and highways. On the contrary, that of gasoline with bioethanol, which was launched in 2006 as well, is not produced anymore since 2010 due to unfavorable prices and limited raw materials.

Keywords: Bioenergy; biofuel; feed in tariff; fuel subsidy; national policy; road map.

1. Introduction

Similar to other ASEAN countries, Indonesia enjoys its ideal location in the equator, where all requirements for effective photosynthesis are fulfilled and therefore plants grow very quickly everywhere. Therefore, biomass exists abundantly in tropical forests, industrial plantations and agricultural fields throughout the country. Due to huge quantity of this biomass entity, it is often called as “the lung of the world”. Moreover, in attempts to achieve zero carbon emission, biomass can naturally serve as bio-CCS for capturing and storage of carbon emission from human activities.

Biomass is used traditionally as energy sources since the beginning of human history. However, in order to avoid “fuel versus food” conflicts, currently exploited biomass should be non-edible or industrial residues. Essentially biomass wastes should never be used as energy source if they are still useful either as animal feed, substitute materials, fertilizers or chemicals. Excellent sustainability and minor environmental impacts of biomass utilization as energy sources have been proved. Theoretically, at the end of 2009 around 80% of national energy generation could be covered by biomass only, but in the reality it was only 3.25% [1]. Most energy demand is unfortunately covered by fossil fuels although the daily oil production decreases steadily. During the oil boom era (1980-1981) the highest production achieved 1.6 millions barrel per day, whereas the daily consumption was only 390,000 barrels. Nowadays, the national oil daily production is around 792,000 barrels, but the demand reaches 1,600,000 barrel per day. The huge deficit is covered simply by importing oils, which make the country become the highest oil importer in the world [2]. Recently Indonesia is still able to export coal and gas, however if no appropriate effort is done to drastically cut down the energy consumption, the country is predicted to become a net energy importer in 2019 when the energy demand surpasses the energy production [3].

Appropriate government strategies regarding fuels and energy are thus required. The government seems having not enough courage to declare urgent situation in the national energy landscape, since almost all citizens still believe firmly that the country has abundant amount of fossil fuel resources. Some policies regarding fossil fuels are decided based more on political rather than economical or environmental viewpoints. A previous report concerning policies and future of bioenergy in Indonesia has been published [4].

2. National Energy Policies

Actually, the government has promoted paradigm shift in the country’s Energy Management, from Supply Side Management in the past into Demand Side Management in the future (see Fig. 1). Previously, fossil-based energy had to be supplied sufficiently without any price consideration, which was

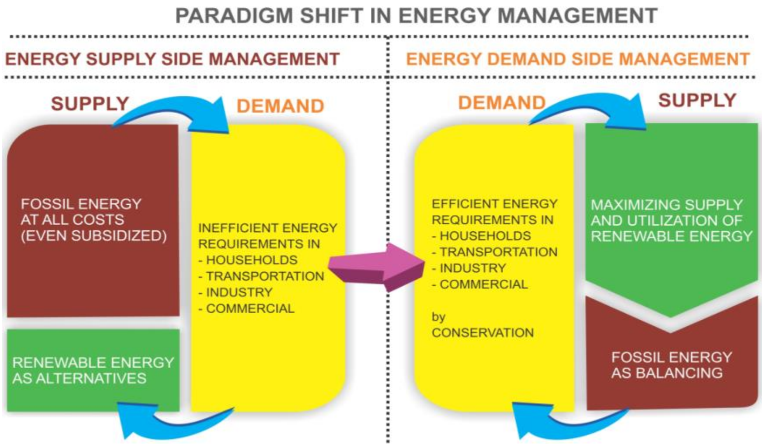

Figure 1. Paradigm shift in energy management [5].

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kept low due to heavy subvention from the government, while Renewable Energy was just an alternative. In such a situation, people enjoyed cheap energy very much and there was no obligation for energy consumers (industry, transportation, commercial, and households) to be efficient. Energy consumption went high, while GDP did not increase appropriately. Research and development in renewable energy was not attractive economically. Its implementation was almost negligible either. In the near future, energy demand for all four sectors will be managed efficiently, and covered mainly by Renewable Energy (including biomass energy), while the smaller rest by fossil fuels. The subsidy for fossil fuels is now gradually reduced and switched to other essential purposes, so that everybody feel encouraged in utilizing and developing renewable energy. All are pushed to be more energy efficient in their daily lives [5].

Recently the government increased oil prices between 30% - 36% in order to reduce oil subventions. Gasoline now costs 8,500 IDR per liter, whereas diesel fuel 7,500 IDR per liter. The fuel subsidy still exists because actually the economical prices are 9,200 IDR for each liter of gasoline and 9,400 IDR for each liter of diesel oil [6]. Oil prices for industry are not changed because they do not enjoy any subvention. It is expected that the price increase can realize the paradigm shift in the National Energy Management sooner.

In order to be more efficient and effective in management of energy resources, the government declares the Vision 25/25, which means that in the year of 2025 the portion of New and Renewable Energy (including bioenergy) is dreamed to be 25%. However, according to the Presidential Decree no. 5/2006 regarding the National Energy Policy, the figure should be more realistically only 17%, as shown in Table 1. Bioenergy can include biofuel (normally in liquid phase for vehicles) and biomass (generally in solid form for power plants). Biogas is excluded due to its very limited quantity. Liquefied coal and nuclear are obviously not renewable energy, but they are classified as new energy sources. Currently, around 11 years before the mentioned year, the total portion of renewable energy is only 5.03% [3].

Meanwhile the government has launched roadmap of bioenergy production from 2015 to 2025 in order to be more specific, as shown in Table 2.

Table 1. Target of New and Renewable Energy in 2025.

No	Energy sources	Amount
1	Biofuel	5%
2	Geothermal	5%
3	Biomass, Hydro, Solar, Wind, Nuclear	5%
4	Liquefied coal	2%
	Total	17%

Table 2. Bioenergy road map.

	Unit	2015	2020	2025
Biofuel	Million kiloliter	**2.69**	**5.80**	**13.51**
Biodiesel	Million kiloliter	2.35	4.73	9.52
Bioethanol	Million kiloliter	0.20	0.80	3.45
Biooil	Million kiloliter	0.13	0.27	0.54
Bioavtur(1)	Million kiloliter	-	0.14	0.16
Biogas	Million cubicmeter	**7.762**	**28.821**	**107.012**
Biomass	MW electricity	**875**	**2,670**	**8,149**

(1) Bioavtur will start with 2% concentration in 2016.

Regarding the blending of biofuel, Ministry of Energy and Mineral Resources releases a biofuel usage mandatory road map, as mentioned in the Ministry Regulation no. 32 / 2008. Table 3 shows the detailed percentage of biofuel [3].

Learning from other countries' success in generating electricity from biomass, the government has released a decree on 31 January 2012 which obliges state-owned PLN, which is the one and only electric company in Indonesia, to buy electricity generated from biomass, biogas and MSW (Municipal Solid Wastes) or excess power from business units with minimum tariffs according to the following Table 4. It is really expected that companies which have excess electrical power from their own biomass-fired power plants can sell it with attractive prices to PLN. There are obviously price differences for interconnection, where low voltages will offer around 350 IDR/kWh higher than those of medium voltage. The diverse incentive factors F are intended to attract more investors to build electric power plants in less

Table 3. Biofuel mandatory road map.

Biodiesel (minimum)						
	2008	**2009**	**2010**	**2015**	**2020**	**2025**
Transportation, subsidized	1%	1%	2.5%	5%	10%	20%
Transportation, non subsidized	-	1%	3%	7%	10%	20%
Industry	2.5%	2.5%	5%	10%	15%	20%
Electricity generation	0.1%	0.25%	1%	10%	15%	20%
Bioethanol (minimum)						
Transportation, subsidized	3%	1%	3%	5%	10%	15%
Transportation, non subsidized	5%	5%	7%	10%	12%	15%
Industry	-	5%	7%	10%	12%	15%

Table 4. Feed in Tariff for electricity sold back to PLN (Less than 10 MW).

Regulations	Energy Source	Tariff (IDR/kWh)		Remarks
		Medium Voltage	Low Voltage	
Ministerial Decree no. 04/2012	Biomass and biogas	975 x F	1,325 x F	▪ F = 1, for Java, Bali, Madura, Sumatra ▪ F = 1.2, for Sulawesi, Kalimantan, Nusa Tenggara ▪ F = 1.3, for Molucca, Papua
	MSW	1,050	1,398	Integrated zero waste technology
	MSW	850	1,198	Sanitary landfill technology.
Ministerial Decree no. 19/2013	MSW	1,450	1,798	Integrated zero waste technology.
	MSW	1,250	1,598	Sanitary landfill technology.
Ministerial Decree no. 27/2014	Biomass	1,150 x F	1,500 x F	▪ F = 1, for Java ▪ F = 1.15, for Sumatra ▪ F = 1.25, for Sulawesi ▪ F = 1.3, for Kalimantan ▪ F = 1.5, for Bali, Lombok, Bangka, Belitung ▪ F = 1.6, for Riau, Papua and others *) ILF, additionally paid by PLN if power plants are operated as load follower.
		80 *)	100 *)	
	Biogas	1,050 x F	1,400 x F	
		70 *)	90 *)	

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developed remote regions with lack of infrastructure, especially in the eastern part of the country. Price differences exist also for electricity generation from MSW, where those generated with integrated zero waste technology always cost 200 IDR/kWh higher than those with sanitary landfill technology.

In order to be even more attractive for investors, the government launches a revision in a Ministerial Decree number 19 / 2013. Electricity from Municipal Solid Wastes now is sold with higher prices, i.e. 400 IDR increase per kWh compared to previous offers. The government really considers the huge potential of MSW, especially in Java island, which amounts to 36,934.3 Tons daily and able to generate 1,530.17 MW electricity [7]. Unfortunately, there is still no incentive factors F for electricity generated from MSW.

Most recently, further revision is made for electricity generated from biomass and biogas. New regulations are launched in a Ministerial Decree number 27 / 2014, which offer more attractive prices. Biomass-to-electricity now costs 175 IDR/kWh higher than before, while Biogas-to-electricity only 75 IDR/kWh higher. There are more detailed and competitive incentive factors F, where remote areas in Papua, Riau and others, can enjoy the highest incentive factor of 1.6. Additionally, there is another incentive if power plants are operated as a load follower, called ILF (incentive for load follower). It will certainly encourage bioenergy program.

3. Barriers for Bioenergy

There are apparently several obstacles for advancement of bioenergy program in Indonesia where fossil fuels have been dominating since decades. People enjoy very much and are already comfortable with all superior characteristics of inexpensive fossil fuels. Several barriers may be common in other ASEAN countries as well, but some others exist particularly in Indonesia. The following barriers have been identified [7].

1. High subsidy for electricity and fossil fuels, especially liquid fuels for transportation, keeps their prices low. People never consider using bioenergy because fossil fuels and electricity are cheap. They do not think about energy efficiency either. Currently the government does not think about shifting subsidy from fossil energy to bioenergy.

2. High investment cost for new bioenergy installations. Strong financial support from the government is really desired to encourage investors and reduce their business risks.

3. Lack of financial institutions (banks) which are interested in biomass development projects. Feasibility studies for bioenergy implementation are mostly not attractive for bank loan.

4. Lack of coordination among related institutions / ministries and companies.

5. Efficiency and reliability of existing biomass technology is still lower than that of fossil fuels.

6. Low capability and acceptance of rural institutions. Most people are reluctant to change their habits. They tend to wait and see before implementing new issues.

7. Fossil fuels are excellent fuels, while biomass is not. It is reasonable because fossil fuels materialize after millions of years, while biomass only several years.

8. Limited funding for bioenergy researches and developments from the government. Companies should be involved to support R&D in bioenergy.

Those barriers seem to be too much and too complicated to overcome. However, learning from success stories of other countries in developing and utilizing bioenergy, Indonesia must be able to be independent gradually from fossil fuels in the near future. People must begin to realize the poor reality of national energy situation and wake up from their daydreams. The government should start introducing new policies to support bioenergy, for example by steadily shifting excessive fossil fuel subventions to other substantial human needs, such as education, health and infrastructure. In 2013, fuel subsidy amounted to 210 billion IDR and electricity subsidy was 100 billion IDR. It made the ratio of energy subsidy to budget expenditure as low as 18.9%. In the previous year 2012 the figure was even worse, i.e. 20.5%. If subsidy portion was dominant, the government had reduced discretion to expand the support for strategic programs [9]. A few percent of the shifted subsidy should be sufficient also to support R & D and implementation of bioenergy.

4. Implementation for Electricity Generation

Perhaps the most useful technology for utilization of biomass is thermochemical conversion to generate heat and power (typically electricity). Electric energy is the best form of energy because it can be used for almost all requirements. The total amount of electricity generated from renewable energy resources in 2010 was 8,772.5 MW, while those from biomass was around 1,709 MW or 19.48% [10]. It was the second rank after Hydro power, then followed by Geothermal power as the third. The next table 5 (total electricity data updated to 2010) and table 6 (on-grid electricity data until 2012) show the installed capacity of electric power plants using biomass as fuels.

Table 5. Installed Capacity of Biomass-fired Power Plants.

No	Island	CAPACITY (MW)			
		2007	**2008**	**2009**	**2010**
1	Sumatra	924.61	924.61	1,607.5	1,687.48
2	Java	10.9	10.9	10.9	11.44
3	Bali, Nusa Tenggara	n.a.	n.a.	9.6	10.08
4	Others	n.a.	n.a.	n.a.	n.a.
	TOTAL	**935.51**	**935.51**	**1,628.0**	**1,709.0**

(source :Statistics of NRE, MEMR, 2011)

Table 6. Biomass based on-grid power plants (until 2012).

No	Company	Location	Biomass Type	Capacity (MW)
1	Riau Prima Energy	Riau	Palm Waste	5
2	ListrindoKencana	Bangka	Palm Waste	5
3	Growth Sumatra (2006)	North Sumatra	Palm Waste	6
4	Indah Kiat Pulp & Paper	Riau	Palm Waste	2
5	Belitung Energy	Belitung	Palm Waste	7
6	Growth Sumatra (2010)	North Sumatra	Palm Waste	9
7	PelitaAgung	Riau	Palm Waste	5
8	PermataHijauSawit	Riau	Palm Waste	2
9	NavigatOrganic	Bali	MSW	2
10	NavigatOrganic (2011)	Bekasi	MSW	6
11	Growth Asia (2011)	North Sumatra	Palm Waste	10
12	Growth Asia (2012)	North Sumatra	Palm Waste	10
13	NavigatOrganic (2012)	Bekasi	MSW	6.5
			Total on-grid capacity	75.5

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Table 7. Consumption of Biofuel for Automotive.

No	Type	Consumption (million liter)			
		2007	2008	2009	2010
1	Bio-diesel	1,550	2,329.1	2,521.5	2,647.57
2	Bio-ethanol	135	192.4	212.5	223.12
3	Bio-oil / Pure Plant Oil	37.2	37.2	40	42
	TOTAL	1,722.2	2,558.7	2,774	2,912.69

In 2013, electricity generated from biomass amounted totally to 1,716.5 MW, consisted of 90.5 MW on grid and 1,626 MW off grid electricity. Off grid electricity was utilized internally by power plant’s owners for production processes [11], as shown by the following three examples of biomass fired cogeneration plants. The first example is found in a Particle Board Factory in Central Java, which uses wood chips, saw dust, forestry products and agricultural wastes as fuels to produce hot combustion gases. Steam and hot oil are then delivered, where the former is used for electricity generation of 4 MW and the latter is applied for heating process [12]. The second example comes from a Palm Oil Factory in Dumai (Riau province), where palm kernel shells of around 59,400 ton/year is used as fuels. Steam of 40 ton/h and 50 bar is produced. Around 20% of the generated steam is used for heating of bleached palm oil and 80% for electricity generation of 3 MW. The steam exhausted from turbine, with lower pressure and temperature, is then used for heating of stearin, fatty acid and others [13]. The last example is a wood wasteand empty fruit bunch fired cogeneration plant in a Plywood and Timber Factory in Sanggau (West Kalimantan province). The generated electrical power is 7 MW [14].

5. Implementation for Liquid Fuel Production

In accordance with satisfactory national economic development in the last decades, more and more transport vehicles are utilized. Consequently, more and more fuels are consumed in Indonesia. In the year 2013 crude oil consumption was 1,368 barrels per day, whereas the daily production was only 942 barrels, and thus the deficit was 426 barrels daily. It is estimated that in 2020 the consumption will climb to 1,636 bpd and the production drop to 676 bpd, which make a deficit of 960 bpd. Those deficits are balanced simply by import although such a choice is really unfavorable for the national economy. One of many means for reducing oil import is blending of conventional fossil fuels with locally available biomass oils. The higher the biomass oil content, the less will be the imported fossil fuels.

Blending product of pure ADO (automotive diesel oil) and biodiesel (FAME) is called BioSolar. It was introduced in 2006 and the trend is constantly increasing. The share in 2011 was 16.79%, while ADO share was 21.51%. Fortunately, Palm Oil is more than enough to produce biodiesel. Coconut oil is appropriate as well, however with less interesting productivity compared to palm oil. Roughly, one million ton per day of CPO (crude palm oil) can produce 20,000 barrel per day of biodiesel.

In contrast, BioPremium and BioPertamax, which were also introduced in 2006, were not marketed anymore since 2010 because the shares were only 0.274% and 0.052%, respectively [15]. BioPremium and BioPertamax were blending of pure gasoline with bioethanol (anhydrous ethanol). The former was subsidized, while the latter not. Therefore, the more bioethanol blended in the fuel, the less the profit. Their prices were consequently not attractive for investors. Moreover, sugar cane and cassava are not enough to produce bioethanol. Other kinds of potential biomass, such as corn, sago and sorghum are unfortunately available with less quantity.

The total supply of biofuel was 46,583 thousands BOE and the national consumption of biofuel for automotive is shown in the next table 7.

Biofuel was consumed entirely for transportation fuel, except bio oil or PPO which was for stationary diesel engines.

Presently the total installed capacity of biodiesel plants is 5.6 million kiloliter/year from 25 registered companies and around 4.5 million kiloliter/year is ready for production. The trend looks very promising, considering that the domestic production of biodiesel in 2012 was 2.2 million kiloliter, which was just about 4 times the production in 2010 (500 thousand kiloliter). Around 50% of the domestic production is consumed in Indonesia and the rest is exported. Before 2012 the content of biodiesel in the subsidized fuel (BioSolar) was 5%, and then increased to 7.5%. Starting from September 2013 it would be 10% (B-10). However for unsubsidized diesel fuels, both for transportation and industry, the content is only 2% (B-2). Increasing biodiesel content and more extensive use of BioSolar will certainly reduce the import of (pure) diesel fuel [16]. Blending of biodiesel into ADO or IDO can significantly reduce small particles and gaseous pollutants. However, care must be taken to anticipate reduced engine performance at higher biodiesel percentage, unless the engine is appropriately modified or the biodiesel characteristics are made approaching those of diesel fuel.

Meanwhile, the total installed capacity of bioethanol plants in Indonesia is 416 thousand kiloliter/year from 8 authorized companies, and 200 thousand kiloliter/year is ready for production. One example is MedcoEnergi Company which runs an ethanol plant in Kotabumi (Lampung province) able to produce 60,000 kiloliters per year of Ethanol 96% using cassava and molasses as feedstock [17]. Unfortunately the prospect in the future is not as optimistic as biodiesel, because even since 2010 there is no blending of pure gasoline with bioethanol anymore. The price of anhydrous ethanol for domestic use is not competitive. It seems that exporting bioethanol is more attractive for investors.

In order to fulfill the biofuel mandatory roadmap, Ministry of Energy and Mineral Resources with full support from many other institutions has launched road tests for vehicles using B-20. Those cars are driven around 40,000 km away through real traffic conditions, such as highways, concrete roads, ups and downs, heavy traffics, and cold weather [18].

References

[1] New Energy Foundation, *Indonesia possesses plentiful biomass Resources*, Available online: www.asiabiomass.jp/english/topics/1209_01.html.

[2] Basri F, Oil and gas industry becomes worse, *Kompas newspaper* (2014) 18 November 2014, p. 1.

[3] Kusdiana D, *Existing and new bioenergy policies needed and implementation target* (2013) presented in Indonesia EBTKE conference and exhibition 2013, Jakarta, 22 August 2013.

[4] Saptoadi H, The future of biomass energy in Indonesia, *Proceeding of 2nd Regional Conference on Energy Engineering* (2014) Bangkok, 13 – 14 November 2014.

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[5] EECCHI (Energy Efficiency and Conservation Clearing House Indonesia), *Efficiency and Energy Conservation in Indonesia* (2011), Directorate General of EBTKE, Ministry of Energy and Mineral Resources.

[6] Brojonegoro BPS, National budget for development : Oil prices increased 2,000 IDR per liter, *Kompas newspaper* (2014) 18 November 2014, p. 1.

[7] Directorate General of EBTKE, *Statistics of New and Renewable Energy* (2013) Ministry of Energy and Mineral Resources, December 2013.

[8] Indarti, *Country paper (Indonesia)* (2001), Presented in Regional Seminar on commercialization of biomass technology, Guangzhou, 4 – 8 June 2001.

[9] Kurniawan R, *Strengthening commitment fiscal policies implementation in biofuel and other Renewable Energy development* (2014), presented in the 3rd EBTKE conference and exhibition 2014, Jakarta, 4 – 6 June 2014.

[10] Directorate General of EBTKE, *Statistics of New and Renewable Energy* (2011), Ministry of Energy and Mineral Resources, March 2011.

[11] Mulyana R, *New, Renewable Energy and Energy Conservation (NREEC): Existing program and breakthrough policies toward achieving national energy policy target*(2014), presented in the 3rd EBTKE conference and exhibition 2014, Jakarta, 4 – 6 June 2014.

[12] Gikoko Kogyo Indonesia, Biomass Co-Generation (2007) Available online: www.gikoko.co.id/content/biomass.html.

[13] CDM – Executive Board, *Nagamas Biomass Cogeneration Project in Indonesia* (2006) Available online: www.dnv.com/focus/climate_change/Upload/PDD%20Nagamas%20Version%201%200.pdf.

[14] CDM – Executive Board, *West Kalimantan Biomass Cogeneration Project* (2006) Available online: www.dnv.com/focus/climate_change/upload/pdd_aes_soutern%20biomass%20biomass%20cogeneration.pdf.

[15] Pusdatin ESDM (Center for data and information on Energy and Mineral Resources – MEMR), *Handbook of Energy and Economic Statistics of Indonesia* (2012), Ministry of Energy and Mineral Resources, 9th edition, December 2012.

[16] Public Communication Center, *Acceleration Program for Utilization of Biofuels* (2013) Ministry of Energy and Mineral Resources, Press Release on 29 August 2013.

[17] Basuki B, *Insight from MedcoEnergi: Bringing renewable energy projects on the ground* (2014) presented in the 3rdEBTKE conference and exhibition 2014, Jakarta, 4 – 6 June 2014.

[18] Public Communication Center, *Launching of road tests for vehicles using B-20* (2014) Ministry of Energy and Mineral Resources, Press Release on 17 July 2014.

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